PERFORMANCE ENERGETIC OF THE SECTOR HYDROLOGIC

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***Abstract*—While greater our knowledge of the behavior of any facility energy consumption rater, the greater the opportunities to implement effective measures to reduce consumption without affecting productivity. In this sense, the prese4nte work aims to determine the Energy Performance of water sector, taking as a case study proposed provision served in Lara State, Venezuela. To achieve this purpose these monthly consumption for a period of 4 years correlated, from 2012 to 2015, we were made correlation graphs and consumption rate was determined. 3,203 Data were analyzed for 125 environment where hydrological facilities in the state are located. The correlation diagrams shown lar trend curves and their correlation. All correlations were close to zero (0) considered weak. The consumption rate calculated average is 0.9561 kWh / m3. Curves consumption rate against water show that the system is more efficient as the water supply exceeds 200.000 m^3.**

Keyword- ***Performance energetic, Sector hydrological, supply of water.***Introduction

I. INTRODUCTION

Currently, energy resources are increasingly limited, therefore the efficient use of electricity is a major issue. Hence the importance of implementing management systems to ensure rational use of these resources and a decrease in consumption. Energy efficiency is evaluated in terms of indicators, indices and targets set to ensure proper implementation of actions to reduce consumption of different types of energy raters. Management systems help establish mechanisms for evaluation and control of any organization. In this way the rules have been published that establish these management systems. Within these standards, the recognized standard ISO 50001 (2011) [1,2] has been presented as an alternative that allows a universal validity, providing basic infrastructure and businesses a set of tools to facilitate their best energy performance and voluntarily, international certification. Understanding this performance as including the use of energy, energy efficiency and consumption of energy raters. In addition, other standards have been published for the proper management of energy, such as IEEE 739 (1995) [3] standards.

In addition, environmental problems such as global warming, as a result of emissions of greenhouse gases (GHG) emissions from the combustion of fossil materials, and high costs of hydrocarbons in general have prompted several agencies and institutions to keep track and control of their energy raters, among these is the food industry [4,5] and production of goods [6], among others. These qualifiers are the consumption of electricity, water, liquid and gaseous fuels, compressed air and others. Reducing consumption affects achieve reduce environmental impact and conserve natural resources.

There is a bidirectional relationship between electrical services and water supply. In countries like Venezuela, for the years 2010 to 2012, average hydropower generation was 51.13% [8-10]. The water supply systems also rely on pumping and booster, usually performed with electric motors. In addition, both power consumption such as water are considered energy raters, regarding regulations on Energy Management Systems (EMS) established in ISO 50001 (2011) [1,2]. Energy raters are brought to the same comparison basis, to verify the contribution of each to the total consumption, and usually this is done with relationships accepted internationally. However it is important to really make local study to quantify this relationship and to adequately understand the relationship between water supply and electrical service. The purpose of this study is to determine the relationship between these variables, which is taken as the basis for studies consumption of electricity and water supply in Lara state, located in Venezuela. For consumption of the water sector is considered the power consumption of its 125

rooms (wells, pumping stations and their offices) and waste water, for the period 2012 to 2015 [11,12]. A total of 3203 data was analyzed.

This paper shows the methodology developed for the study, its main findings and conclusions

II. METHODOLOGY

Similary what happens with other management systems, the SGE aims to plan, implement and verify wide measures to reduce consumption of energy raters without sacrificing productivity or transfer known as efficient borders, shown in Figure 1 of any installation. This system is based on achieving defined the Energy Performance of qualifiers, so that they are true to life, so that they serve to verify the effectiveness of the actions implemented.

Fig. 1. Efficient borders

ISO 50001 (2011) [1,2] believes that proper energy management is necessary to carry indicators show you the energy performance of energy rater of each organization. It is necessary to adequately measure and record the behavior of the same in order to verify the effectiveness of the measures implemented to reduce consumption. This paper aims to determine the performance of the water sector of the Lara State, located in Venezuela. Lara State is one of the 24 federal entities in the country, with an approximate area of 19,800 km2 and a population of 2,019,211 inhabitants, 2015. The Lara state is located in the west central region of the country and it is divided into eleven (11) municipalities. The water supply company of Lara state has 125 rooms, including wells and pumping stations or booster and administrative offices. The hydrological system features engines ranging from 20 to 500 Hp.

The methodology used in the study is to determine the correlation between energy consumption environments and administrative offices and the supply of water from the local water company, for which they had followed the following steps:

1. Registration of monthly electricity consumption of 125 rooms and administrative offices of the local water company for the period of 2012 to 2015 was obtained.

2. Registration was obtained water supply, coinciding with the electric power.

3. Correlation diagrams were made by municipality. In practice, using a statistical package, the correlation coefficient of the sample (r), or Pearson or correlation coefficient Pearson product moment, describing the intensity of the relationship between the two variables (in our case is determined, energy consumption in kWh and water in m3), and can take any value between -1.00 and +1.00. When it has a value of +1.00 -1.00 indicates perfect or, respectively positive or negative linear relationship between dependent and independent variables the, so forecasts be perfectly reflections of reality. Conversely, if the coefficient Pearson r is close to 0 it indicates that the relationship between variables is weak.

4. The rate of consumption (kWh / m3) as the ratio of energy consumption (kWh) and water supply (m3), both for the same measurement period is determined.

III. RESULTS AND ANALYSIS

To determine the Energy Performance of Hydrological Sector consumption of water and electricity monthly 125 environments (wells and pumping stations or booster and administrative offices) Lara State, Venezuela, was determined for each municipality charts correlation was analyzed and consumption rate. The Table I shows a summary of consumption for the years 2012 to 2015, distributed by municipality, the consumption of electrical energy (kWh) and the water supply (m3), this analysis is performed by municipality and year of study .

Table I. Water and energy consumption by municipality of Lara State for the period from 2012 to 2015

Municipality	2012		2013		2014		2015	
	Energy (kWh)	Production (m3)	Energy (kWh)	Production (m3)	Energy (kWh)	Production (m3)	Energy (kWh)	Production (m3)
Iiribarren	37.215.076,00	48.511.221,10	35.429.582,00	50.710.053,32	34.902.798,00	46.841.076,59	34.046.542,00	44.861.209,99
Alto Tocuyo	66.875.468,00		70.174.953,00		69.116.770,00		70.533.264,00	
Andres Eloy Blanco	297.546,00	2.117.663,80	299.952,00	1.899.076,70	316.137,00	1.962.395,44	345.835,00	1.848.179,10
Crespo	1.859.856,00	5.242.499,44	1.762.311,00	4.966.271,58	1.585.343,00	4.937.078,57	1.617.656,00	4.702.217,38
Cuji-Tamaca	1.464.229,00	838.654,42	1.467.073,00	977.916,74	1.482.651,00	760.200,00	1.494.369,00	731.081,31
Jimenez	972.493,00	12.625.000,00	932.033,00	13.467.059,00	912.825,00	13.512.788,00	948.025,00	13.429.483,93
Moran	2.977.294,00	5.765.403,60	2.786.506,00	5.670.582,59	2.747.251,00	5.797.216,18	2.867.139,00	5.530.573,08
Palavecino	20.215.505,00	30.231.519,98	20.298.149,00	31.763.016,37	20.113.212,00	31.020.289,09	20.805.271,00	31.280.956,03
Simon Planas	1.233.051,00	4.269.621,16	1.169.943,00	3.180.293,70	1.128.418,00	3.108.290,08	1.109.027,00	2.955.076,84
Torres	11.789.154,00	41.140.790,43	11.949.649,00	41.549.766,48	11.814.939,00	38.447.766,85	11.891.067,00	43.320.790,31
Urdaneta	2.610.070,00	4.370.651,53	2.734.882,00	3.237.757,86	2.921.567,00	3.190.617,52	2.924.102,00	3.036.653,08
Total	**147.509.742,00**	**155.113.025,46**	**149.005.033,00**	**157.421.794,34**	**147.041.911,00**	**149.577.718,32**	**148.582.297,00**	**151.696.221,05**

By way of example, Figures 2 and 3 show, by way of example the scatterplot of Iribarren and Urdaneta respectively municipalities by 2015. The municipality Iribarren is an urban area where there are established industrial, commercial sectors and residential, unlike Urdaneta, which is residential and agricultural area. In both graphs the correlation is less than 0.01. It is said that the correlation is acceptable when it is above 0.75 [3-7].

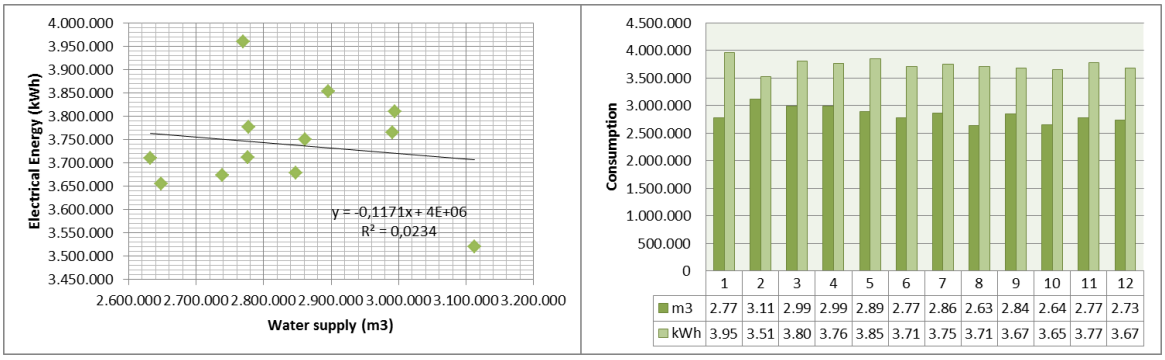

Figure 2. Scatterplot of the municipality Iribarren 2015 20

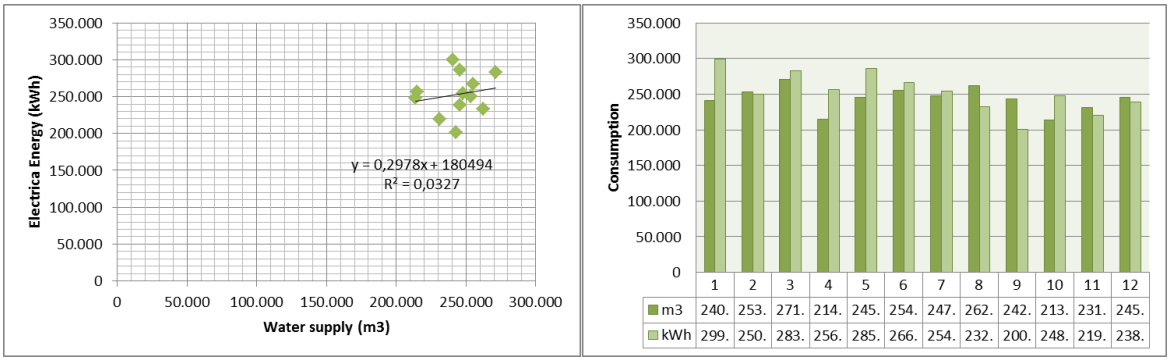

Figure 3. Scatterplot of the municipality Iribarren 2015

In Figure 2 we can see that although water consumption varies in months, with the lowest value in August with 2,632,029 m3, the power consumption is similar in every month of the year, approximately 3,738,434 kWh average, similar to non-production (when x = 0) of 4,000,000 kWh consumption. Which results in a weak

correlation as shown in Fig of 0.0234. Unlike what happens in Figure 2, Figure 3 shows a higher correlation, although it has a significant difference from the ideal of 0.75. This is observed to see that there is a slight similar behavior between monthly consumption of electricity and water supply.

One of the important aspects to assess the energy performance of any installation is the use of the rate of consumption (kWh / m3) which is shown in Table II for the period under study. In this Table II it shows that this indicator fell from 0.9724 to 0.9579 kWh / m3, in the year 2012 compared to 2015, respectively, being on average of 0.9651 kWh / m3.

Table II. Energy performance of water supply in Lara state

Year	Electrical Energy (kWh)	Water supply (m3)	Relationship (kWh/m3)
2012	147.509.742	151.696.221	0,9724
2013	149.005.033	149.577.718	0,9962
2014	147.041.911	157.421.794	0,9341
2015	148.582.297	155.113.025	0,9579
Average	**148.034.746**	**153.452.190**	**0,9651**

Figure 4 shows the index ratio calculated consumption and water supply for the period of 2012 to 2015, considered in the study. This can be seen that when the water supply is less than about 100,000 m3, there are significant differences in consumption rate ranging from 1.95 to 1.75 kWh the / m3. However, as the production of water supply is increased, even exceeding 200,000 m3, the rate of consumption of the study period approaches every year and has the lowest values of 0.47 to 0, 28 kWh / m3, making the system more efficient, demonstrating that increased production the use of resources are maximized.

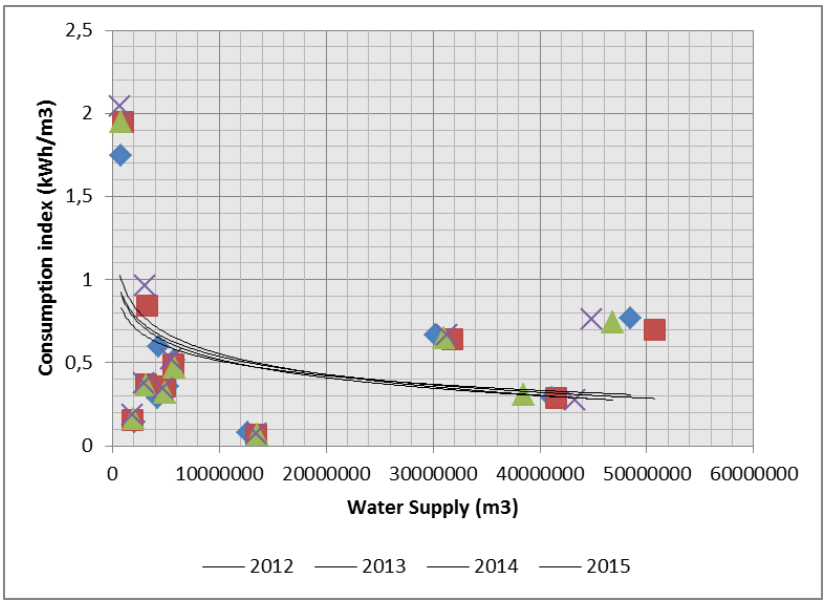

Fig. 4. Index consumes against water supply (m^3)

IV. CONCLUSION

The results are a first reference that relates the monthly consumption of electricity and water supply, which brings benefit a significant contribution to knowledge. According to this study the correlation between the consumption of electricity and water supply are weak, would find in every case under near zero (0). It was established that for 3,203 data analyzed for the period 2012 to 2015 on average was obtained that the relationship between two variables is 0.9651 kWh / m3. In addition to this decreases index of 0.9724 to 0.9579 kWh / m3, in the year 2012 to 2015, respectively. That is, there was a decrease of 1.5% of the energy needed to ensure the supply of water, although the latter increased from 151,696,221 to 155,113,025 m3 for the years 2012

and 2015, respectively. The graph of rate against water consumption shows that the system becomes more efficient as the production increases.

ACKNOWLEDGEMENT

The authors of this paper want to recognize institutions Hidrolara CA and CORPOELEC CA for their invaluable to the development of this research contributions..

REFERENCES

[1] ISO 50.001- 2011. Energy Management.
[2] Acevedo, R; Vásquez, C. y otros. Análisis relacional de la norma ISO 50.001 (2011): sistemas de gestión energética. Revista de Ciencia y Tecnología AGROLLANíA. Volumen 11. (2014). Pp 312-323.
[3] IEEE std. 739-1995. Recommended Practice for Energy Management in Industrial and Commercial Facilities (IEEE Bronze Book).
[4] Vera, J; Hernández, Determinación del índice de consumo de una empresa de Lácteos. Revista Energética. Vol XXIV. No. 1/2003. Pp 9-16. La Habana, Cuba.
[5] Cedeño, E. Comportamiento de los índices de consumo energético de la empresa arrocera de la provincia de Cuba. Revista Ciencias Técnicas Agropecuarias. Vol. 18. No. 1/2009. Pp 76-81.
[6] Pérez, C; Vera, F. Indicadores de gestión enfocados al ahorro energético para la industria de beneficio de feldespato. Scientia et Technica Año XVI, No 49, Diciembre de 2011. Universidad Tecnológica de Pereira
[7] Zhaohui. Analysis of Energy Consumption and Industrial Structure in Henan Province.
[8] MPPEE. Anuario Estadístico 2010. Año 2012. Documento en línea. [Consulta 30 Enero 2016]. Disponible en http://www.mppeuct.gob.ve/
[9] MPPEE. Anuario Estadístico 2011. Año 2013. Documento en línea. [Consulta 30 Enero 2016]. Disponible en http://www.mppeuct.gob.ve/
[10] MPPEE. Anuario Estadístico 2012. Año 2014. Documento en línea. [Consulta 30 Enero 2016]. Disponible en http://www.mppeuct.gob.ve/
[11] Colmenaréz, N. 2015. Estudio de las estaciones de Bombeo y suministro eléctrico de la empresa HIDROLADA CA. Trabajo de pasantía como requisito parcial para obtener el título de Ingeniero electricista. Unexpo, Venezuela
[12] Figueredo, R. 2016. Índice de consumo del sector hidrológico. Trabajo Especial como requisito parcial para obtener el título de Ingeniero electricista. Unexpo, Venezuela

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